In re application of: Bright, et al.

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For: Porous Abrasive Articles with Agglomerated Abrasives and Method for Making the Agglomerated Abrasives

Amendments to the Claims

Claims 1-37 (canceled)

38. (original) A bonded abrasive tool, having a structure permeable to fluid flow, the tool comprising:

a) about 34-56 volume % abrasive grain;

b) about 3-25 volume % bond; and

c) about 35-80 volume % total porosity, including at least 30 volume % interconnected porosity;

wherein the interconnected porosity has been created without the addition of porosity inducing media and without the addition of elongated shaped materials having a length to cross-sectional width aspect ratio of at least 5:1.

Claims 39-49 (canceled)

50. (original) An abrasive tool comprising 5 to 75 volume % abrasive grain agglomerates, made by a method comprising the steps:

a) feeding abrasive grain and a binding material, selected from the group consisting essentially of vitrified bond materials, vitrified materials, ceramic materials, inorganic binders, organic binders and combinations thereof, into a rotary calcination kiln at a controlled feed rate;

b) rotating the kiln at a controlled speed;

c) heating the mixture at a heating rate determined by the feed rate and the speed of the kiln to temperatures from about 145 to 1,300° C,

d) tumbling the mixture in the kiln until the binding material adheres to the grain and a plurality of grains adhere together to create a plurality of sintered agglomerates;

e) recovering the sintered agglomerates from the kiln, the sintered agglomerates consisting of a plurality of abrasive grains bonded together by the binding material and having an initial three-dimensional shape and a loose packing density of $\leq$ 1.6 g/cc;

f) molding the sintered agglomerates into a shaped composite body; and

g) thermally treating the shaped composite body to form the abrasive tool.

51. (original) The abrasive tool of claim 50, further including the step of mixing the sintered agglomerates with a bond material to form an agglomerate mixture.

52. (original) The bonded abrasive tool of claim 51, wherein the bond material is a vitrified bond material.

53. (original) The vitrified bonded abrasive tool of claim 52, wherein the vitrified bond has a bond firing temperature at least 150° C lower than the binding material melting temperature.

54. (original) The bonded abrasive tool of claim 50, wherein the binding material comprises a material selected from the group consisting essentially of ceramic materials, vitrified materials, vitrified bond compositions and combinations thereof.

55. (original) The bonded abrasive tool of claim 54, wherein the melting temperature of the binding material is about 800 to 1,300° C.

56. (original) The bonded abrasive tool of claim 55, wherein the binding material is characterized by a viscosity of about 30 to 55,300 poise at the melting temperature of the binding material.

57. (original) The bonded abrasive tool of claim 55, wherein the binding material is a vitrified bond composition comprising a fired oxide composition of 71 wt% SiO_2 and B_2O_3, 14 wt% Al_2O_3, less than 0.5 wt% alkaline earth oxides and 13 wt% alkali oxides.

58. (original) The bonded abrasive tool of claim 54, wherein the binding material is a ceramic material selected from silica, alkali, alkaline-earth, mixed alkali and alkaline-earth silicates, aluminum silicates, zirconium silicates, hydrated silicates, aluminates, oxides, nitrides, oxynitrides, carbides, oxycarbides and combinations and derivatives thereof.

59. (original) The bonded abrasive tool of claim 50, wherein the interconnected porosity is obtained without the addition of pore inducing media.

60. (original) The bonded abrasive tool of claim 50, wherein the tool further comprises about 35-80 volume % total porosity, including at least 30 volume % interconnected porosity.

61. (original) The bonded abrasive tool of claim 52, wherein the tool has a maximum density of 2.2 g/cc.

62. (original) The bonded abrasive tool of claim 50, wherein the sintered agglomerates have an average size dimension two to twenty times larger than the average size of the abrasive grain.

63. (original) The bonded abrasive tool of claim 50, wherein the initial size range of the sintered agglomerates is 200 to 3,000 micrometers in average diameter.

64. (original) The bonded abrasive tool of claim 50, wherein the abrasive grains are microabrasive grains and the initial size range of the sintered agglomerates is 5 to 180 micrometers in average diameter.

65. (original) The bonded abrasive tool of claim 60, wherein the interconnected porosity of the tool is characterized by a relative air permeability value (Q/P) in cc/second/inch of water at least 10% higher than the Q/P of a comparable bonded abrasive tool made without the sintered agglomerates.

66. (original) The bonded abrasive tool of claim 51, wherein the tool comprises 35 to 52 vol % sintered agglomerates, 3 to 13 vol % vitrified bond and 35 to 70 vol % porosity.

67. (original) The bonded abrasive tool of claim 50, wherein the tool further comprises at least one component selected from the group consisting of secondary abrasive grain, filler materials, grinding aids, pore inducing media and combinations thereof.

68. (canceled)

69. (original) A method of grinding, comprising the steps of:

a) providing a bonded abrasive tool, having a structure permeable to fluid flow, the tool comprising:

1) about 34-56 volume % abrasive grain;

2) about 3-25 volume % bond; and

3) about 35-80 volume % total porosity, including at least 30 volume % interconnected porosity; wherein the interconnected porosity has been created without the addition of porosity inducing filler material and without the addition of elongated shaped materials having an aspect ratio of at least 5:1;

b) bringing the bonded abrasive tool into contact with a workpiece; and

c) abrading the surface of the workpiece with the bonded abrasive tool.

70. (original) A method of agglomerating abrasive grain, comprising the steps:

a) feeding the grain and a binding material, selected from the group consisting essentially of vitrified bond materials, vitrified materials, ceramic materials, inorganic binders, organic binders, water, solvent and combinations thereof, into a rotary calcination kiln at a controlled feed rate;

b) rotating the kiln at a controlled speed;

c) heating the mixture at a heating rate determined by the feed rate and the speed of the kiln to temperatures from about 145 to 1,300° C,

d) tumbling the grain and the binding material in the kiln until the binding material adheres to the grain and a plurality of grains adhere together to create a plurality of sintered agglomerates; and

e) recovering the sintered agglomerates from the kiln,

whereby the sintered agglomerates have an initial three-dimensional shape, a loose packing density of $\leq$ 1.6 g/cc and comprise a plurality of abrasive grains.

71. (original) The method of claim 70, further comprising the step of making a uniform mixture of the abrasive grain and the binding material and then feeding the mixture into the rotary calcination kiln.

72. (original) The method of claim 70, wherein the mixture is tumbled in the heating kiln for about 0.25 to 2.0 hours.

73. (original) The method of claim 70, wherein the sintered agglomerates are two to twenty times larger in size than the abrasive grain.

74. (original) The method of claim 70, wherein the kiln is tilted to an angle of incline of about 0.5 to 5 degrees.

75. (original) The method of claim 70, wherein the kiln is rotated at a speed of 0.5 to 10 rpms.

76. (original) The method of claim 71, wherein the mixture is fed into the kiln at a feed rate of about 5 to 910 Kg/hr.

77. (original) The method of claim 71, wherein the mixture feed rate is set such that the mixture occupies 8-12 volume % of the kiln volume.

78. (original) The method of claim 70, wherein the sintered agglomerates have a minimum crush strength of 0.5 at 50% crush fraction in a compaction test.

79. (original) The method of claim 71, wherein the mixture further comprises at least one component selected from the group consisting of secondary abrasive grain, filler materials, grinding aids, pore inducing media and combinations thereof.

80. (original) The method of claim 71, wherein the mixture further comprises pore inducing media selected from the group consisting of hollow glass spheres, ground walnut shells, hollow spheres or beads of plastic material or organic compounds, foamed glass particles, bubble mullite and bubble alumina, and combinations thereof.

81. (original) The method of claim 70, wherein the grain and the binding material are heated to a temperature of 800-1200° C in the kiln.

82. (original) The method of claim 81, wherein the temperature is effective to cause the binding material to melt and flow and the viscosity of the melted binding material is at least 300 poise.

83. (original) The method of claim 71, wherein the uniform mixture is agglomerated to form green agglomerates and then the green agglomerates are fed into the rotary calcination kiln.

84. (original) Sintered agglomerates of abrasive grain, made by a method comprising the steps:

a) feeding abrasive grain with a binding material into a rotary calcination kiln at a controlled feed rate;

b) rotating the kiln at a controlled speed;

c) heating the mixture at a heating rate determined by the feed rate and the speed of the kiln to temperatures from about 145 to 1,300° C,

d) tumbling the grain and the binding material in the kiln until the binding material adheres to the grain and a plurality of grains adhere together to create a plurality of sintered agglomerates; and

e) recovering the sintered agglomerates from the kiln,

whereby the sintered agglomerates have an initial three-dimensional shape, a loose packing density of $\leq$ 1.6 g/cc and contain a plurality of abrasive grains.

85. (original) The sintered agglomerates of claim 84, further comprising at least one component selected from the group consisting of secondary abrasive grain, filler materials, grinding aids, pore inducing media and combinations thereof.

86. (original) The sintered agglomerates of claim 84, wherein the binding material comprises a material selected from the group consisting essentially of selected from the group consisting essentially of vitrified bond materials, vitrified materials, ceramic materials, inorganic binders, organic binders, organic bond materials, metal bond materials and combinations thereof.

87. (original) The sintered agglomerates of claim 84, further comprising the step of making a uniform mixture of the abrasive grain and the binding material and then feeding the mixture into the rotary calcination kiln.

88. (original) The sintered agglomerates of claim 84, wherein the sintered agglomerates have an average size dimension two to twenty times larger than the average size of the abrasive grain.

89. (original) The sintered agglomerates of claim 84, wherein the initial size range of the sintered agglomerates is 200 to 3,000 micrometers in average diameter.

90. (original) The sintered agglomerates of claim 84, wherein the abrasive grains are microabrasive grains and the initial size range of the sintered agglomerates is 5 to 180 micrometers in average diameter.

91. (original) The sintered agglomerates of claim 84, wherein the granule comprises about 30-88 volume % porosity.

92. (original) The sintered agglomerates of claim 91, wherein up to 75 volume % of the porosity comprises interconnected porosity.

93. (original) The sintered agglomerates of claim 84, wherein the relative density of the agglomerates, as measured by a fluid displacement volume technique and expressed as a ratio of the volume of the agglomerates to the apparent volume of the abrasive grain and the binder material used to make the agglomerates, is a maximum of 0.7.